

Patent Application of  
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for  
GAME CONTROL WITH ANALOG PRESSURE SENSOR(S)

5 This is a Rule 1.53(b) continuation application of my  
pending U.S. Application 08/942,450 filed 10/01/1997, now  
U.S. Patent 6,102,802 (to be filled in later), to  
which the benefit of the earlier filing date is claimed  
for the common matter.

10 BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to controllers of the  
type used and held by two hands simultaneously to control  
visual imagery shown on a visual display. More  
15 specifically, the present invention pertains to a two hand  
held controller with analog pressure sensor(s) for  
controlling video game imagery thereof, and other  
electronically generated imagery. Methods of use and  
manufacturing are also disclosed.

20 2. Description of the related Prior Art:

There are many prior art game controllers for use in  
controlling imagery. A typical prior art game controller  
is shown in U.S. Patent 5,207,426 issued May 4, 1993 to Y.  
Inoue et al and assigned to Nintendo Co. Ltd. The  
25 Nintendo controller is a typical example of a game  
controller having multiple inputs capable of manipulating  
multiple-axes, such as with the included cross-shaped  
rocker key pad, and numerous buttons and depressible  
surfaces. The Nintendo controller includes a housing  
30 sized to be grasped and held simultaneously by two hands  
of a human user with thumbs of the grasping hands

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proportional joystick is applied in an attempt to overcome the significant disadvantages of the four simple On/Off switches located under the typical cross-shaped rocker pad. The proportional joystick includes at least two major disadvantages which are overcome by the present invention. The first disadvantage is cost of manufacture, and the second is confusion of the user. In a controller to be made in millions of units, two relatively expensive optical encoders, a complex gimble, multiple mechanical parts specific for the joystick, etc. creates an additional substantial cost which is very high. The second disadvantage is confusion of the user in that the typical user has become commonly accustomed to use of the cross-shaped key pad with the left thumb. The presentation of the option of the proportional joystick with the N64 controller often leads to confusion as whether to use the cross-shaped key pad or the joystick, especially for beginning users and potential buyers.

Clearly there is great advantage to the user's enjoyment of the game by allowing the user proportional or variable control.

The primary emphasis of this disclosure is to teach analog pressure sensor(s) embodiment in a controller having only a single housing structured to be held in the user's two hands simultaneously. Nevertheless, a joystick type of controller can be greatly advantaged by embodiment of analog sensors as described herein. The joystick type controller may be held in two hands simultaneously but it is not a single housing held in two hands. Rather, a joystick includes two housings, a base housing and a handle housing neither of which are designed to be held in two hands simultaneously. The joystick type controller may be greatly advantaged by inclusion of depressible surfaces (buttons and/or triggers) operating analog sensors as described herein. Such embodiments will become apparent to those skilled in the art with a study of this

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## SUMMARY OF THE INVENTION

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manufacturing game controllers are also herein disclosed.

Applied physical pressure is provided by a user of the present controller depressing a button or like depressible surface (e.g., cross-shaped key pad or finger depressible trigger which is commonly a pivotal member) which applies pressure onto pressure-sensitive variable-conductance material which, dependant upon the applied pressure, alters its conductivity (i.e., resistive or rectifying properties dependant on pressure sensor material utilized) and thereby provides analog electrical output proportional to the applied pressure. The analog electrical output of the variable-conductance material is output to an image generation machine as a signal at least representational of the analog electrical output for controlling electronic imagery.

Examples of use of the invention (controller) in a game for control of action intensity of the electronic imagery can be to simply have a simulated character walk with low depressive pressure applied, walk faster with increased depressive pressure applied, and run with a relatively high depressive pressure applied to a single depressible surface depressible individual button of the controller in accordance with the present invention. The user can choose the action intensity of imagery by applying appropriate depressive pressure to depressible surfaces of the depressible individual buttons of the controller. In a second example, a race car can veer slightly with a low depressive pressure and turn sharply with a high depressive pressure. In an example of typical right thumb use (or finger of the right hand as is typical in joystick use) of the controller, variable depressive pressure can control variable fire rate of a gun or variable jumping height of a character, etc.

The present invention in one embodiment involves a game controller sized and shaped to be grasped and held simultaneously by two hands of a human user with thumbs of

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5 airplane or controlling directional movement of a  
character such as the running direction of a simulated  
person. The present two hand held controller allows for  
placement of depressible control surfaces for certain  
functions in areas of the controller which are generally  
10 most suitable for typical human users. Additionally, a  
two handed controller provides the user the advantageous  
ability to hold the controller in both hands with the  
controller in the user's lap or held in front of the user  
and free of the constraints of needing a desk top or like  
15 surface on which to rest the controller.

20    imagery by the degree of pressure exerted on a depressible  
surface.

25 proportional joystick is required when proportional  
controls are applied to a cross-shaped rocker key pad.

Another object of the present invention is to provide an inexpensive to manufacture analog input controller.

Another object of the present invention is to provide  
30 a game controller in which right hand thumb buttons may  
also be pressure-sensitive proportional (analog input)  
control(s).

Another object of the present invention is to provide an improved method of using a game controller connected to an image generation machine with visual display, in which  
35 a user depresses depressible surfaces using hand digits on

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a game controller to manipulate imagery on the display, wherein depressing of at least one of the depressible surfaces with varying degrees of pressure manipulates imagery of the display in proportion to the degree of depressive pressure.

Another object of the present invention is to provide a method of controlling action intensity of imagery within a visual display of the type associated with an electronic game allowing user manipulation of action of imagery within the visual display by way of depressing a depressible surface onto a pressure-sensitive variable-conductance sensor connected to electronics within a two hand held game controller linked to an image generation machine such as a game console or computer which in turn is linked to the display, and wherein depressing of a depressible surface with varying degrees of pressure varies the conductance of the pressure-sensitive variable-conductance sensor, thereby the action intensity of the imagery can be proportional to the degree of depressive pressure.

Another object of the present invention is to provide an improved method of manufacturing a two hand held type game controller including installing pressure-sensitive variable-conductance material for varying electrical output of circuitry in proportion to user applied pressure to a depressible surface.

These, as well as additional objects and advantages will become increasingly appreciated with continued reading and with a review of the included drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a traditional prior art game controller commonly referred to as a game pad having a left hand area and a right hand area with the left hand area having a cross-shaped rocker pad depressible in four codependant areas, under each area is an associated On/Off momentary-

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On switch (electricity manipulating devices), four switches, one under each depressible area. The right hand area has depressible individual buttons located over On/Off momentary-On switches (electricity manipulating devices).

Fig. 2 shows a Nintendo N64 prior art game controller. This controller illustrates the growing need for variable or analog input control in the incorporation of the complex rotary encoder joystick. This controller has typical traditional right hand area depressible buttons and also a typical cross-shaped depressible rocker pad in the left hand area.

Fig. 3 shows a cross section view of a resilient dome cap mounted over a circuit board having a first and a second circuit trace including pressure-sensitive variable-conductance material in a sensor arrangement in accordance with the present invention.

Fig. 4 shows a top view of first and second conductive traces with finger-like traces laying opposed in proximity with one another.

Fig. 5 shows a cross sectional view of a resilient dome cap operatively associated with pressure-sensitive variable-conductance material atop interdigitated traces on a circuit board in accordance with the present invention.

Fig. 6 shows a top view of first and second interdigitated circuit traces.

Fig. 7 shows a cross sectional view of a resilient dome cap supporting and operatively associated with pressure-sensitive variable-conductance material above interdigitated traces on a circuit board in accordance with the present invention.

Fig. 8 shows the sensor of Fig. 7 in a depressed or activated state.

Fig. 9 shows an exploded view of one controller in accordance with the present invention.

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Fig. 10 is a graph illustrating depressive pressure in relation or in proportion to the conductivity of a pressure sensor, which typically corresponds to action intensity of imagery on the game display.

5 Fig. 11 shows a game controller of a traditional format in accordance with the present invention for example. The game controller is shown connected by wires to an image generation machine (game console or personal computer) which drives a display such as a television or  
10 computer monitor.

#### BEST MODES FOR CARRYING OUT THE INVENTION

Referring now to drawing figures 3-11 for descriptions of preferred embodiments and best modes for carrying out the invention. As previously mentioned, the  
15 present invention includes a game controller which is a two hand held controller sized and shaped to be grasped and held simultaneously by two hands of a human user with thumbs of the grasping hands remaining substantially free of grasping responsibilities so as to be available and  
20 useful in depressing a plurality of depressible surfaces 22 each at least in-part exposed on housing 20 to be accessible by the user's digits. A plurality of electricity manipulating devices 24 are contained (or at least in part contained) within housing 20 in operable  
25 association with the plurality of depressible surfaces 22 for manipulating electrical outputs with depression by the user's hand digits (thumbs or fingers) of the plurality of depressible surfaces 22. Electricity manipulating devices 24 in this disclosure can be any electrical device such as  
30 simple Off/On (momentary-On) switches as are commonly used in prior art game controllers, but with the present invention at least one of the electricity manipulating devices 24 is an analog pressure-sensitive variable-conductance sensor 26 for varying electrical output  
35 proportional to varying physical pressure applied by the

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user's thumb or fingers on a depressible surface 22 positioned to apply pressure to pressure-sensitive variable-conductance material 36 of sensor 26 as will be detailed.

5           Shown in Fig. 3 is a pressure-sensitive variable-conductance sensor 26 or analog sensor as it may installed by a manufacturer within a game controller in accordance with the present invention. Resilient dome cap 28 is shown made of rubbery material, such as injection molded  
10   silicone rubber, mounted over a circuit board 30 having a first circuit trace 32 and a second circuit trace 34 and including pressure-sensitive variable-conductance material 36 contacting both traces 32, 34, and an electrically  
15   conductive plate 38 is shown atop pressure-sensitive variable-conductance material 36. An underside portion of depressible surface 22 is shown atop dome cap 28. Dome cap 28 is a resilient dome providing a return spring lifting depressible surface 22 and provides or serves the purpose in this example of supporting depressible surface  
20   22 raised upward until manually depressed to cause the lower or inner surface of dome cap 28 to press against plate 38 which in turn presses against pressure-sensitive variable-conductance material 36 which, as will be detailed, changes its conductivity with applied pressure  
25   to alter the conductance of the electrical path provided thereby between the first and second conductive traces 32 and 34 which are in close proximity to one another yet separated. Sensor 26 can be used in replacement of a simple momentary-On switch within a game controller  
30   wherein a momentary-On switch simply closes the circuit across the first and second traces 32 and 34 while the user presses on depressible surface 22 and the closed circuit outputs a known and fixed output (On or Off, or open or closed), while with the application of sensor 26  
35   depressing of depressible surface 22 provides variable electrical flow across the first and second circuit traces

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Pressure-sensitive variable-conductance material 36  
is an important aspect of the present invention. Variable  
conductance can be achieved with materials having either  
variable resistive properties or variable rectifying  
properties. For the purpose of this disclosure and the  
claims, variable-conductance means either variably  
resistive or variably rectifying. Material having these  
qualities can be achieved utilizing various chemical  
compounds or formulas some of which I will herein detail  
for example. Additional information regarding such  
materials can be found in U.S. patent 3,806,471 issued to  
R.J. Mitchell on April 23, 1974 describing various  
feasible pressure-sensitive variable-conductance material  
formulas which can be utilized in the present invention.  
While it is generally anticipated that variable resistive  
type active materials are optimum for use in the pressure  
sensor(s) in the present invention, variable rectifying  
materials are also usable.

An example formula or compound having variable rectifying properties can be made of any one of the active materials copper oxide, magnesium silicide, magnesium stannide, cuprous sulfide, (or the like) bound together with a rubbery or elastic type binder having resilient

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depressible surface 22 can be an end portion of a four-way rocker or four-way key pad 42 as shown in Figs. 9 and 11. For further clarity, depressible surface 22 and electricity manipulating device 24 are herein described and shown as separate elements, but they are only necessarily separate in a functional sense (i.e., physical depressing function verses electrical controlling function). In practical application, depressible surface 22 and electricity manipulating device 24 may be structured as one part. For example, the upper part of dome cap 28 protruding through housing 20 could itself be exposed to contact by a hand digit to function as the depressible surface 22 as shown for example in Figs. 7 and 8.

Fig. 4 shows first and second electrically conductive traces 32, 34 with finger-like traces laying in proximity with one another which can be the form of the first and second conductive traces 32, 34 of Fig. 3. The spacings between the conductive finger-like trace elements shown in Fig. 4 allow for adhesive which can be used to adhere a layer or disk of pressure-sensitive variable-conductance material 36 to circuit board 30 if so desired by the manufacturer.

Shown in Fig. 5 is a second pressure-sensitive variable-conductance sensor 26 or analog sensor embodiment as it may be installed by a manufacturer within a game controller useful with the present invention. Resilient dome cap 28 is mounted over circuit board 30 having first and second circuit traces 32, 34 and including pressure-sensitive variable-conductance material 36 contacting both traces 32, 34. Optional plate 44 is shown atop pressure-sensitive variable-conductance material 36. An underside portion of depressible surface 22 is shown atop dome cap 28. Depressible surface 22 is shown in-part supported by housing 20, which in this example is housing 20 providing lateral support against the side of surface 22 and

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additionally with surface 22 including a lower flange  
abutting the underside of housing 20 and thereby being  
prevented from escaping housing 20. Optional plate 44 in  
this arrangement can be a stiff plate utilized as a  
5 physical load distributor to distribute compressive loads  
received from the underside of dome cap 28 with depression  
of depressible surface 22 across material 36 and not be an  
electrical conductor, or alternatively it can also be an  
electrical conductor dependant upon the particular  
10 thickness of material 36 and or spaced distance between  
circuit traces 32 and 34 beneath material 36. Plate 44  
does not have to be applied atop material 36 in all  
embodiments. Circumstances which effect the determination  
as to whether plate 44 or conductive plate 38 for that  
15 matter are used atop material 36 include: the particular  
formula of material 36; dimensions of the applied material  
36; the size, shaped proximity and layout of the circuit  
traces in contact with material 36, and manufacturing  
considerations such as is material 36 directly applied to  
20 plate 44 or 38 in an easily handled disk and then adhered  
to the circuit board 30, or applied directly to circuit  
board 30 and traces 32, 34 such as by application in a  
fluid mixture (uncured) using a removable mask; or  
directly injected onto circuit board 30 such as with  
25 injection molding; or a pill/disk of material 36 is sliced  
from a cured cylinder or extrusion of material 36 and the  
pill/disk adhered to circuit board 30 and/or traces 32,  
34; and other manufacturing techniques.

Fig. 6 shows a top view of closely interdigitated  
30 circuit traces 32 and 34 in a form as may likely be used  
in the sensor structures shown in Figs. 5, 7 and 8.

Shown in Figs. 7 and 8 is a third pressure-sensitive  
variable-conductance sensor 26 formed as a depressible  
individual button which is an analog sensor embodiment as  
35 it may be installed by a manufacturer within a game  
controller or used by a user of the game controller in

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accordance with the present invention. Rubber dome cap 28 is mounted over circuit board 30 having first and second circuit traces 32, 34 and including pressure-sensitive variable-conductance material 36 on the bottom side of resilient dome cap 28. An upper exposed portion of dome cap 28 is exposed exterior of housing 20 so that depression by a thumb or finger of depressible surface 22 causes downward movement or depression of dome cap 28 to bring material 36 into contact with traces 32 and 34.

Depressible surface 22 is shown in-part supported or laterally stabilized by housing 20. Material 36 is not permanently contacting traces 32 and 34 as is shown in Fig. 3 and 5, but instead is on the underside of dome cap 28 in pill or disk form and raised or held upward above traces 32, 34 by dome cap 28 until, as indicated in Fig. 8, surface 22 is depressed to push dome cap 28 downward to bring material 36 into contact with traces 32, 34 which, under pressure, establishes a conductive path across traces 32, 34. Also shown in Figs. 7 and 8 is the surface of material 36 which contacts traces 32 and 34 is convexed which in this particular application provides for the apex of the surface to first contact across traces 32 and 34 followed by material 36 which is flexible deforming with additional applied pressure to somewhat flatten-out and contact additional surface area of both traces 32 and 34. This arrangement of relatively lower initial surface area contact followed by additional or a larger surface area contact with further depression can provide additional conductivity changes due to not only the inherent conductivity changes brought about by pressure applied to material 36 but also by establishing additional current paths possible by the additional surface contact area. Material 36 in Fig. 7 and 8 can be formed with a flat bottom surface and function adequately without the increasing surface area effect provided by the convexed shape shown. Additionally sensors 26 of Figs. 3, 5, 7 and

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5 In the prior art, typically a carbon-rich conductive pill or disk is located on the underside of a typical dome cap such as dome cap 28. In the prior art carbon-rich conductive pills are employed as simple On/Off momentary-On switches wherein the pill is depressed by the user onto  
10 and across circuit traces to close the circuit and released to open the circuit. In the prior art, the carbon-rich pill is a component of a switch that is only an On/Off switch. The prior art carbon-rich conductive pill is commonly used exclusively as an improved On/Off  
15 switch with the improvement being that this is considered a bounce-less switch not subjecting the circuitry to rapid on/off oscillations at the time of initial depression. Carbon-rich pills are typically made of granular carbon in high concentrations in a silicone rubber binder producing  
20 a resilient conductive material resistant to mechanical bouncing when depressed onto a surface. The carbon-rich pill is utilized to advantage in a simple On/Off bounce-less switch.

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ideal choice as an analog sensor in a human hand operated controller.

In the range of light depression by a typical user's thumb or finger (i.e., approximately one to six ounces) a carbon-rich pill as a variable resistor may typically have a range of resistance from a high value of approximately 3 thousand ohms to a low value near 10 ohms, which is a narrow range compared to a tungsten carbide based material 36 which may typically have a range from approximately 3 million ohms down to a low of approximately 10 ohms. Thus, the tungsten carbide based material 36 has a range of nearly 3 million ohms, while the carbon-rich pill has a range of nearly 3 thousand ohms, resulting in an improvement of three magnitudes (i.e., one thousand times) in range of the tungsten carbide material 36 over the carbon-rich pill.

Tungsten carbide having an extreme resistance range as a function of physical depressive pressure allows for greater variation (higher resolution) of physical pressure applied within those levels normal to light use by the thumb or finger of a typical human user. The variable resistance range of tungsten carbide is additionally quite stable over a wide temperature range. Tungsten carbide also has excellent wear characteristics and minimal hysteresis. Therefore, tungsten carbide is a preferred active material for use with the present invention.

Within the scope of the invention, material 36 can be manufactured and fixed in place with numerous processes not yet detailed, and for example, tungsten carbide can be mixed with un-crosslinked silicone rubber and extruded from a tool or pressed into a cylindrical mold, allowed to crosslink, and then cut or sliced into disks or pills of material 36 which can then be placed in appropriate location to circuit traces 32, 34 or on dome cap 28. Another process is to mix tungsten carbide or other suitable material with an injection moldable silicone

rubber and then inject the material onto any desireable surface such as a membrane surface such as mylar, or circuit board 30 and traces 32, 34, or using an injection process for creating dome cap 28 with disks or pills of material 36 thereon, such as could be performed for the dome cap 28 and material 36 arrangement of Fig. 7 and 8, or dome cap 28 can be a flexible/resilient dome cap and material 36 can be molded either onto the dome cap or onto the circuit board, etc. If a metal dome cap is used and is electrically conductive, one circuit trace such as trace 32 can make electrical contact with a foot of the dome cap and the second trace below the approximate center of the dome cap with material 36 positioned between the second trace and the center of the dome cap such that depression of the dome cap effectively sandwiches material 36.

Fig. 9 shows an exploded view of a controller in accordance with one embodiment of the present invention. Shown at the top of the view is an upper portion 50 of housing 20. Upper portion 50 of housing 20 includes on the right hand side a pair of circular holes 52 for receiving and in-part supporting (retaining) depressible surfaces 22 which in this example are buttons 40. On the left hand side of the housing top is a cross-shaped opening 54 through the housing for in-part receiving and supporting a four-way rocker 42 which is a depressible surface 22. The depressible surfaces when assembled into the housing are in-part exposed on the housing surface for depressing by the digits of the human hands. Shown below the housing upper portion 50 is rocker 42 and buttons 40. Additionally shown are individual rubber dome caps 28 beneath button 40 and a four-gang rubber dome cap 28 beneath rocker 42 having four codependant areas. Shown beneath the rubber dome caps is circuit board 30 having on its left side an array of circuit traces forming four areas including adjacent circuit traces 32 and 34 in close

proximity to one another for operative engagement with material 36 installed by the manufacturer atop each of the four areas which are located such that the four-gang rubber dome cap can be applied over the four locations of material 36 to provide a dome cap over each material 36 location. Rocker 42 can then be located atop the four-gang rubber dome cap so that one dome cap is located underneath each one of the four arm structures (four codependant areas) of rocker 42. Each arm of rocker 42 is placed one arm above each of the four locations of material 36. Rocker 42 is supported elevated above material 36 by dome caps, and when housing 20 is fully assembled with a lower portion 56 of housing, a flange 58 on the lower outward edge of rocker 42 prevents rocker 42 from completely passing through cross-shaped hole 54. Shown on the right side of circuit board 30 are two locations of applied material 36 installed by the manufacturer over separated yet in close proximity to circuit traces 32 and 34. The two individual dome caps 28 will be placed one over each material 36 location of the right side of the board 30, and button 40 positioned onto dome caps 28, the upper surfaces of buttons 40 positioned through holes 52 and housing 20 and circuit board 30 connected to one another and housing 20 closed with upper portion 50 and lower portion 56 affixed together. Also shown on circuit board 30 is circuit traces 32 and 34 connecting to active electronics 46 installed by the manufacturer and electronics 46 having the capacity to output a signal at least representational of the analog electrical output of pressure-sensitive variable-conductance sensor(s) 26 into output cable 48 leading to an image generation machine 60 such as a game console or computer connected to a display (Fig. 11). Active electronics 46 (i.e., ASIC or micro-controller integrated circuitry, etc.) which in addition to having normal circuitry of a typical game controller such as a prior art

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5 For the sake of brevity and because it is well known to those skilled in the art, this disclosure does not detail converting analog to digital signals, i.e., specifically converting the output of sensors 26 to a digital signal or form for control of imagery. It is conceivable that  
10 within the scope of the invention, circuit traces 32 and 34 could simply be connected directly to conductors of cable 48 for outputting a signal at least representational of the analog electrical output of pressure-sensitive variable-conductance sensor(s) 26 through output cable 48  
15 into an image generation machine 60 wherein active electronics 46 may be located.

Examples of typical left thumb use of the invention in a game can be to simply have a simulated character shown on the display walk with low depressive pressure applied to a depressible surface 22 of sensor 26, walk faster with increased depressive pressure applied to the

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depressible surface 22, and run with a relatively high depressive pressure applied to the same depressible surface 22, with this being an example of controlling or changing the action intensity of the imagery

5 proportionally with changes in depressive pressure applied to depressible surface 22 of sensor 26. The user can choose the action intensity of imagery by applying appropriate depressive pressure. In a second example, a race car can veer slightly with a low depressive pressure applied to surface 22 of sensor 26 and turn sharply with a high depressive pressure applied to the same depressible surface 22. In a typical right thumb use and an example of use of the invention, variable depressive pressure can control variable fire rate of a gun or variable jumping height of a character shown as an image on display 62. Alternatively, the invention in combination with an electronic game console or PC and display can be arranged so the action intensity of the imagery is reduced proportionally to increases or increasing depressive pressure applied on depressible surface 22 of sensor 26 wherein a simulated race car shown on the display travels at a high rate with little or no depressive pressure applied to surface 22, and is slowed proportionally to increased or increasing depressive pressure applied by the user to the depressible surface 22 of sensor 26, an arrangement wherein the sensor 26 is applied as a braking system.

Fig. 11 shows a game controller of a traditional format in accordance with the present invention for example. The game controller is shown connected by cable 48 to an image generation machine 60 such as a game console or personal computer which drives a display 62 such as a television, computer monitor or head-mount display, etc.

35 Although I have very specifically described preferred structures and best modes (methods) of the invention, it

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